

Except for questions 18–20, and 32 marks/answers on these sheets are not graded.

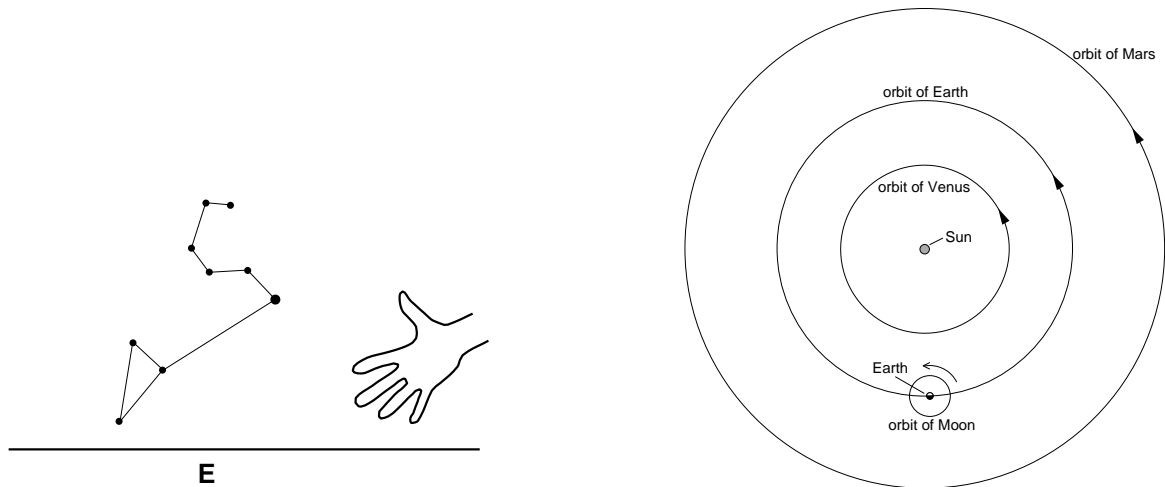
**Answer *TRUE* or *FALSE* (not *T* or *F*) (2 pts each)**

1. If SI units (the “metric system”) were being properly used a “micro phone” would be a thousand times smaller than a normal phone.
2. Right ascension is analogous to latitude; declination is analogous to longitude.
3. A diurnal circle is a great circle.
4. *Altitude* is the angle between a star and the celestial equator.
5. Every vertical circle passes through the observer’s zenith.
6. If in the morning the Sun is in the constellation Taurus, by the afternoon it would have moved on past the constellation Cancer.
7. The far side of the Moon is continuously dark.
8. The changing direction of the Earth’s axis (the axis pointing in different directions during the year), is the primary cause of the seasons.
9. Ptolemy lived and died before Christ.
10. Copernicus and Luther were alive at the same time.
11. Since Venus and Saturn both orbit the Sun, from Earth they both display all possible phases from new to full.
12. Newton’s second law states that the speed of an object is proportional to the force and inversely proportional to its mass.
13. According to Newton, a constant force is needed to keep an object moving with a constant velocity.
14. A satellite orbiting the Earth in a circle at a constant speed is not accelerating.
15. Since the Earth is more massive than the Moon, the gravitational force of the Earth on the Moon is greater than the gravitational force of the Moon on the Earth.
16. The force of gravity on an orbiting astronaut is *tiny* (i.e., much less than it is on the surface of the Earth).

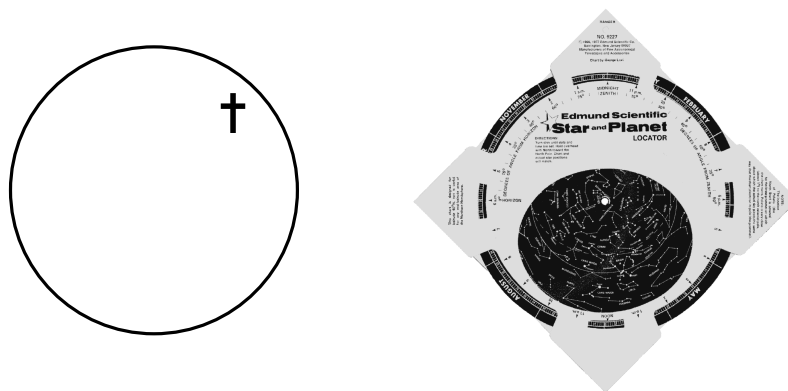
**Give a short explanation (5 pts each)**

17. Explain why the stars seen at night during the winter differ from those seen at night during the summer.

18. The below right picture shows the inner (Mars & in) Solar System as seen from a distant fixed point high above the Earth's north pole. The arrows show which way the planets go around the Sun (which is also the way the Earth spins). On Easter (27-Mar-2016) Venus will be well past its maximum elongation in the morning sky moving towards a superior conjunction with the Sun in June, Mars will be approaching the start of its retrograde period which begins 17-Apr-2016, and the Moon will be in waning gibbous phase. Directly on the below left diagram, write a "L" to denote the Easter location the Moon in the Solar System, "M" to denote the Easter location of Mars and "V" to denote the Easter location of Venus. Use " $\sigma$ " to denote the location of Mars on 17-Apr-2016.



19. Consider the above left picture of a 9 P.M. view looking east at CSB/SJU. Directly on top of this picture (using the same horizon), sketch what the view would look like 1 hour later.
20. The below left is a (mostly empty) sky map for CSB+SJU. Directly on this sheet sketch and label: meridian, north celestial pole, due east horizon. Assume the cross is a star pattern in the sky. Draw on your answer sheet a horizontal line representing the horizon and place a cross above your line showing how you would see this star pattern oriented in the sky.

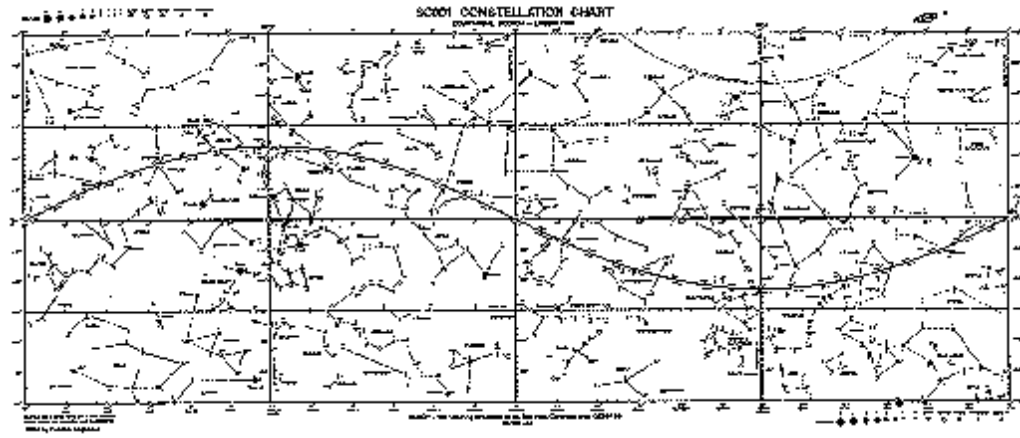


21. Consider the (re-touched) photocopy of your Star Locator shown above right. Redraw on your answer sheet the Star Locator's oval that represents the sky and clearly label where the following are found: zenith, meridian, north celestial pole, celestial equator and the east point on the horizon.
22. Describe the cause of our seasons. (I.e., why in Minnesota is it colder in December than it is in June?)

23. Draw a picture showing the relative positions of the Sun, Moon and Earth during a solar eclipse. What is the 'line of nodes'? Why is it that eclipses can happen only when the Sun is near the line of nodes. How many times per year is the Sun near the line of nodes?
24. Sketch the rectangle that represents the celestial sphere on the SC001. (See question 32, if you forget what this looks like.) Draw the path of Saturn on your map over a five year period. If Saturn starts in conjunction with the Sun, approximately how long until Saturn is moving retrograde? Between the time of conjunction and time of retrograde, is Saturn a morning star or an evening star?
25. The Moon is waxing crescent today (12 Feb 2016). Clearly explain *when* and *where in the sky* (approximate the direction you would be facing and the altitude you would be looking) you could see the Moon today. The end of classes is 10 weeks (77 days) away. Clearly explain *when* and *where in the sky* you could see the Moon at the end of classes (and how you made that determination). What will be its phase?
26. Galileo noted that Venus shows the same set of phases as the Moon shows (i.e., crescent, half, gibbous, full, waxing/waning), and concluded (unlike the Moon) that Venus must go around the Sun. Explain how in this case similar data (same phases) lead to opposite conclusions (around Sun or Earth). Draw a picture showing the planetary arrangement producing a new phase for Venus and the Moon. Draw a picture showing the planetary arrangement producing a full phase for Venus and the Moon.
27. Identify an important contribution of each of the following people: Kepler, Tycho, and Ptolemy.
28. While making a tight left-hand turn in a car the books piled in the passenger seat next to you slide into the passenger door and are pegged there until you complete your turn. Why? Draw a picture showing the situation as seen from high above the car. Show: the path of the turn, the direction of any horizontal forces acting on the books, and the direction the books would go if there were no forces acting on them.

**Write out a complete answer (10 pts each)**

29. Cairo, Egypt has a latitude of about  $30^\circ\text{N}$  and a longitude of about  $31^\circ\text{E}$ . On Easter (27-Mar-2016) the planet Mars will have a right ascension of  $16^h 19^m$  and a declination of  $-20^\circ$ . Report the time of day (on Easter 2016) when Mars will cross the meridian and its altitude at Cairo (you must report your reasoning to receive any credit). Was Mars visible at sunrise? sunset?
30. The space shuttle can "orbit" the Earth, i.e., not fall down, for a long time. How does that work? What exactly is needed? Astronauts in the space shuttle float, i.e., nothing seems to hold them down. How does that work?
31. (a) Draw an ellipse and display on your drawing the location of the Sun and a semi-major axis. Label on your ellipse the spot where the planet would be moving its fastest and where the planet would be moving slowest. State Kepler's second law (that has to do with varying speeds in an orbit).
  - (b) Starting again, draw a new picture of an orbit around the Sun with a large eccentricity. Add to this diagram (and clearly label "smaller") an additional orbit about the Sun with a smaller eccentricity. Which of your orbits has the longer period?



32. Consider the above (re-touched) photocopy of your SC001 star map. *On your answer sheet*, redraw the map's rectangle that represents part of the celestial sphere and clearly label where the following are found: celestial equator, ecliptic, point of R.A.=0 (spring equinox), a hour circle and a diurnal circle. On the above photocopy SC001 show the Easter location of the Sun, Moon, Venus, and Mars. (FYI: Questions 18 and 29 may be of use.)